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ABSTRACT

The first stage of the HyTuS (Hypermedia Tutoring System) project, developed by the Alliance Francaise (a training institute supplying French courses for foreigners in France and abroad), and professional partners, is presented. The aim of the project is to provide a hypermedia CD-ROM-based environment for learning French according to the Alliance Francaise educational programs, and to provide learners with specific views (WEBs) of the CD-ROM database. Two aspects are considered: the first one, purely pedagogical, tackles the need to focus a learning session to a restricted number of topics. The second one is a technical problem: some training centers are still based on traditional teaching methods and are not well equipped with high quality computers, and cannot implement CD-ROM based training sessions. The solution is to provide them with a magnetic disk containing particular sub-sets of the educational hypermedia CD-ROM version. The WEB specification model proposed constitutes an extension of a widely accepted hypertext reference model, the DEXTER model, extended using the MACT formalism. The learning program is composed of several hypermedia sequences; each of them is focused on a particular problem and contains modules which treat a particular aspect of the sequence main subject. Links to or from other modules of the same sequence are managed by the HyTuS pilot. The internal structure involves the three levels of the educational hypermedia: the hyperdocument, the supervision system, and the computer assisted instruction (CAI) components. WEB specification and extraction mechanisms are detailed. Concepts are illustrated in three figures. (Contains 14 references.) (MAS)

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Hypermedia Tutoring System : Towards an Architecture Dedicated to the WEB Specification

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Abstract: In this paper, we present the first stage of the HyTuS project (Hypermedia Tutoring System). This project originated by the *Alliance Française* Institute is a cooperation between University and professional partners (*Alliance Française* is a training institute supplying French courses in France (for foreigners) and abroad. It is composed of more than 2000 centres all over the world). The aim of the project is to provide a hypermedia CD-ROM-based environment for learning French according to the *Alliance Française* educational programs. In this paper, we have studied the problem related with its distribution. The aim is to provide the learners with specific views (WEBs) of the CD-ROM database. Two aspects are considered : the first one, purely pedagogical, tackles the need to focus a learning session to a restricted number of topics. The second one is a technical problem : some training centres are still based on traditional teaching methods and are not well-fitted out with high quality computers. Consequently, some of them cannot put into practice CD-ROM-based training sessions. The solution is to provide them with a magnetic disk containing particular sub-sets of the educational hypermedia CD-ROM version.

Aims and framework of the HyTuS project

The first stage of the project was initiated by a profitable team-work in which pedagogues and teachers' needs and dreams were confronted to computer scientists' reality (costs, calendars, ...).

It was decided to focus the prototype to the second level morpho-syntax aspects of the *Alliance Française* institute learning program. Taking into account the diversity of learners (age, nationality, curriculum, ...) was one of the major French Institute requirements. Fortunately, this problem was yet well resolved (at least theoretically) in A.P.I. works (Beltran, 1991; Beltran, 1992; Beltran, 1993), ...

Defining Educational Hypermedia sessions

The hypermedia is designed to be adapted to several pedagogical aims and contexts (several strategies related with the second level of the learning program are implemented). The CD-ROM covers several months of traditional training, but learning sessions have to be short and focussed on topics defined by both learners and instructors. Consequently, we have to manage this fragmentation, providing the learner with sharply defined views of the knowledge base (or 'WEBs', according to the hypermedia literature).

• Virtual (or logical) partitions : a pedagogical requirement

The WEB structuring of knowledge is a classical mean which aims to avoid getting lost in a hypermedia document, particularly when they are used for CAL purposes (Richards & Mühlhaüser, 1993). But, the definition of navigation strategies and user models is not enough in the CAI context of our architecture (Hypermedia-based tutoring system). The web definition must be still stronger because a HyTuS web has to be organized according to particular pedagogical aims (not only navigation contexts) : revision of concepts, overview, detailed presentation, exercises, knowledge checking, ... Each pedagogical strategy implies a particular behaviour of the supervision system, that is to say a particular web management. On the other hand, new constraints impose the creation of physical partitions.

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• Physical partitions : a technical and organizational requirement

The CD-ROM solution seems to be the best support for data storage and distribution. However, some *Alliance Française* training centres are isolated and poorly equiped (with personal computers of several capabilities). So the tele-teaching architectures proposed in numerous works (TeleTeaching, 1993; Applica, 1993), (network-based and often requiring expensive devices) are unsuited for our problem. This has led us to study the distribution of hypermedia webs (particular views) using more traditional supports, such as removable hard disks (e.g. SyQuest) or floppy disk packages. Later on, we shall describe the web extraction mechanism.

The WEB specification (see figure 1)

The model we propose (Beltran, 1993), constitutes an extension of a widely accepted hypertext reference model : the DEXTER model (Halaz & Swartz, 1990; Safe, 1990). The educational hypermedia CD-ROM is composed of hypermedia knowledge (information, links, ...) plus, the textual representation (DEXTER formal description of the hypermedia document : (a) in fig.1). This description, or a copy (a'), is used by the 'WEB specification tool' in order to define the WEB corresponding to the parameters stated by the instructor (b) : learner profile, pedagogical aims, characteristics of the target computer(s), ... A dialogue with the instructor allows him to refine the WEB to be produced. Next, from both the WEB specification document (c) and the hypermedia database, the extraction tool builds a physical partition, satisfactory from both pedagogical and technical points of view (d).

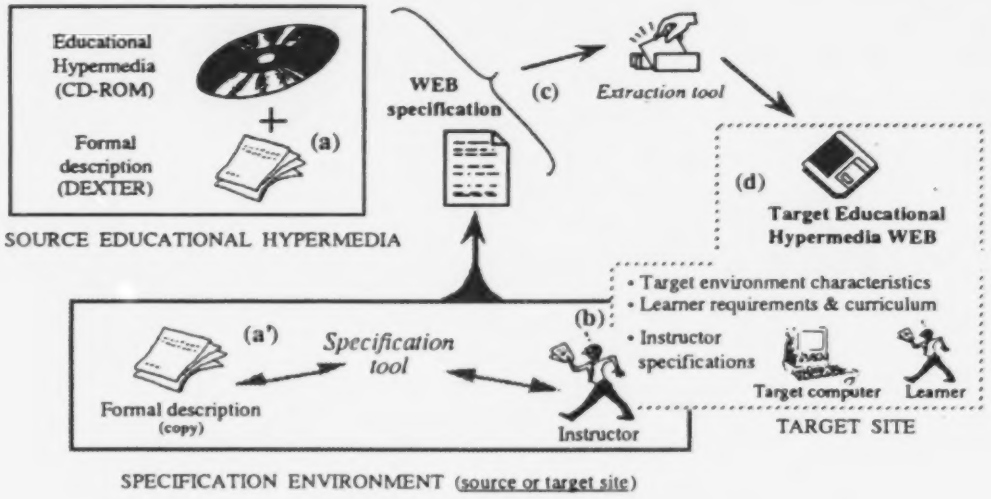

Figure 1. Specifying an Educational hypermedia WEB

Three possible configurations

• Each computer of the training centre is connected to a CD-ROM device (directly or by network): at the beginning of a learning session, the learner chooses among a set of WEB specifications prepared by the instructor. The WEB is automatically computed by the extraction tool at navigation time.
• The majority of training computers is not connected to a CD-ROM device : in spite of this, the instructor can specify the WEB (only the formal representation is needed). Next, if a computer of the centre can read a CD-ROM (local or remote device), the WEB is built and stored on a magnetic support. To be used by the learners, the WEB should be installed on the target computers.
• In the case where no CD-ROM device is available, the instructor sends the web specification document to a centre having CD-ROM devices. The WEB is built and returned to the instructor.
This process allows poorly equiped centres to provide the learners with adapted learning programs (e.g. presentation of the first month topic courses, revision of sequence 1, exercises and complements of modules 4 and 5, ...).

The on-going HyTuS prototype : the Hyperdocument structure

Organization of knowledge (figure 2)

Structuring knowledge in Hypermedia sequences, composed of several modules allows, at the upper level a topical navigation. Moreover, this organization suits the WEB specification.

The learning program is composed of several sequences; each of them is focussed on a particular problem (such as the negation : '*ne .. pas*') and contains modules which treat a particular aspect of the sequence main subject (for example : a module to learn sentences including '*ne pas...*'; another where '*ne*' and '*pas*' are separated with only a verb; ...). Several types of multimedia Hypermedia-organized exercises are proposed; complements can be consulted.

According to the strategy stated by the instructor or the learner, the hypergraph of the module is dynamically computed. The evaluation of the learner interaction within a module depends also on the HyTuS strategy. Links to or from other modules of the same sequence are managed by the HyTuS pilot.

The Hypermedia Tutoring System allows the user (instructor or learner) to decide which strategy will be used during the session. Several parameters can modify the supervision of the learner interaction with a module, the paths within a module, the linkage of sequences, ... A set of relevant supervision parameters has been decided by the pedagogues of the *Alliance Française* Institute.

A tool for HyTuS behavior specification is now being developed and allows to set the following supervision settings:

Notation	**Access to complements**	**Module browsing**
• 20 points if answer is found, 0 if not • Depending on the number of possible answers	• Always • Only if the point average > 'x' • Never	• Overview (x% of exercises) • Complete • Learner choice

Exit module (link to another module)	**Answer analysis**	**Exit sequence** (to another sequence or end)
• At end • If point average > 'x' and 'y' % of exercises are done	• After each exercise • After each module • After each sequence	• At end • If point av. > 'x' and 'y' % of modules • According to learner errors

Error treatment (link between sequences)	**Sequence and module calling**	**Sequence and module priority**
• Do not take into account • Take into account but continue • Treat immediately & go back • Treat immediately & don't go back	• According to priority list(s) • According to learner errors	• Instructor list • Learner list • Predefined lists depending on the learner language

Taking into account the CAI components of the educational hyperdocument

In this purpose, the MACT model (Péninou & Gouardères 1993a; Péninou & Gouardères 1993b), designed to knowledge base management in ICAI systems, seems particularly suited. This model is based on the notion of pedagogical primitive (also refereed in Woolf, 1991; Van Marcke, 1992; Major & Reichgelt, 1992). MACT defines four components:

• an Object base representing the system reasoning context (curriculum, available pedagogical styles, learner interaction, ...).

• a Task base representing high level functions of the system. Each task represents a pedagogical primitive and takes into account a system pedagogical function or a system pedagogical objective. A task defines the set of shared objects and describes the identifiers of needed tasks, considering a specific context. Several agents are associated to a task.

• an Agent base, in which each agent is designed to perform its associated task in a specific context. This context is determined by 'pre' and 'post' condition attributes defined for each agent.

• a run-time engine which runs MACT specifications, manages the object base sharing and the selection of agents in order to realize a task (by checking 'pre' conditions and selecting agents). This mechanism can be compared with the functioning of the GTE system (Generic Tutoring Environment, (Van Marcke, 1992)).

This model, adapted to our needs, allows the definition of pedagogical contexts within an educational hypermedia document. It is also a good support for the extraction of coherent pedagogical WEBs. Let us now present the external structure of the HyTuS Hyperdocument being developed.

The Task / Agent internal structure of the Hypermedia Tutoring System

The Hypermedia specification (based on the DEXTER model, extended using the MACT formalism) constitutes a standard description of both hypermedia information and supervision components. The pedagogical primitives tasks allow the representation of pedagogical aims related to a specific use of the hyperdocument.

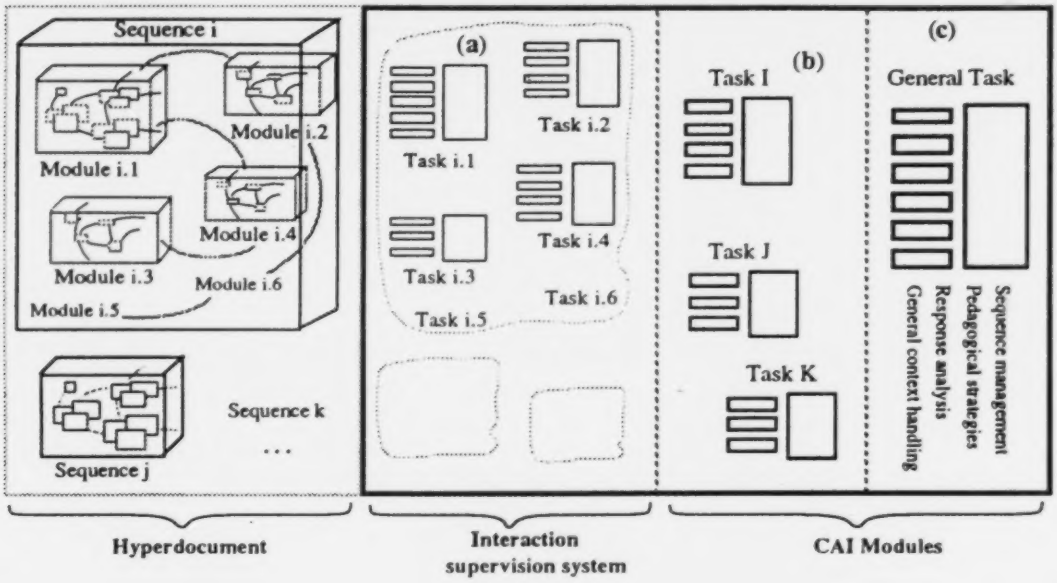

Figure 2. The tasks / agents internal structure

This representation involves the three levels of the educational hypermedia : the hyperdocument, the supervision system and the CAI components (see figure 2).

- A task, named 'Module Task' is linked to each module of the hyperdocument (a). Agents, named 'Module Agents' attached to this task describe the module management in a specific context. Each agent is owner of a list containing the Static Links (classical links: SL) and another containing the Pedagogical Links (supervised dynamic links : PL) defined for the module. These two lists allow the system to know which information is needed when the module is activated, according to particular supervision parameters (exercise notation, exit module parameters, access to complements, module browsing, answer analysis, error treatment).
- A task, named 'Sequence Task' is associated to each sequence of the hyperdocument (b). In the same way, agents named 'Sequence Agents' are associated to this task. A list of 'Needed Modules' (NM), addressing the modules able to be activated is associated to each Sequence Agent. These agents define the sequence management with regard to the parameters stated by the instructor, i.e. the system behaviour settings (access to complements, sequence browsing, exit sequence parameters, answer analysis and error treatment).
- Finally, the HyTuS pilot is represented by the 'General Task' (c), its agents, named Pilot Agents define the parameters related to the supervision context : error treatment, sequence or module priority and calling, ... A list of 'Needed Sequences' (NS) addressing the sequences able to be activated is associated to each Pilot Agent.

The object base contains : • data related to the supervision parameters, • objects shared by both the Pilots Agents and the user interface management system (event-based system).

The agents connected to each task are in charge of one or several combinations of the supervision parameters. The activation of an agent (controlled by the attributes named 'pre' and 'post' conditions) depends on the values of both • the hypermedia / supervision system shared objects and • the supervision parameters.

Specifying WEBS

A Web specification consists in delimiting particular hypermedia knowledge with regard to : • the possibility to install the Web on a target computer, • the satisfaction of the constraints stated by the instructor related both to the information content and the interaction supervision. Extractions are made thanks to queries based on the DEXTER representation extended with the pedagogical oriented MACT overlay. We propose a step by step approach, resumed by the figure 3.

Topic / Subtopic Selection (DW : Domain Web) From a topic browser and a table of contents presenting the hypermedia units (sequences and modules), a first set of queries defines a Domain Web (DW). This DW is only content satisfactory in regard of the instructor specifications.

Supervision Parameters Setting & Task / Agents Extraction (PW : Pedagogical Web) Each DW supervision task is analysed : according to the supervision parameters, only relevant agents (for pedagogical management) are selected (module agents, sequence agents and pilot agents having relevant activation 'pre' conditions). From the selected Module agents and their lists of links (SL and PL lists), a PW Web is generated.

Topic / Pedagogical Completeness checking (DPW : Domain Pedagogical Web) DW and PW do not always strictly overlap (PW units may not belong to DW, or reciprocaly). In order to obtain the resulting DPW, a compromise between DW and PW must be found (feed-back to the two previous steps). At this stage, selected domain information is linked to the selected control agents.

Technological Requirements & Improvements (DPTW : Domain Pedagogical Technological Web) From the DPW and the extended DEXTER representation, the Web size estimation is made and compared with the target computer capabilities. Adaptations can be achieved (modifying pictures and movies quality, sound definition, ...) in order to fit the computer characteristics. The resulting WEB is analysed from a technological point of view.

When the Specification DPTW matches a Good pedagogical / technological Compromise, the web is found. Else, if DPTW characteristics do not match the instructor requirements, a feed-back to the previous steps is needed (the resulting web will be truncated or extended).

Satisfaction Criteria The final Web size can be reduced according to several points of view :

- only few sequences are needed (those refereed in the selected pilot agents NS lists),
- only few modules are chosen (those refereed in the selected sequence agents NM lists),
- concerning the selected modules, only few agents are needed, so, only few units of hypermedia information (SL and PL lists of the module agents) are associated to the final web,
- size of information can be tailored to technological requirements.

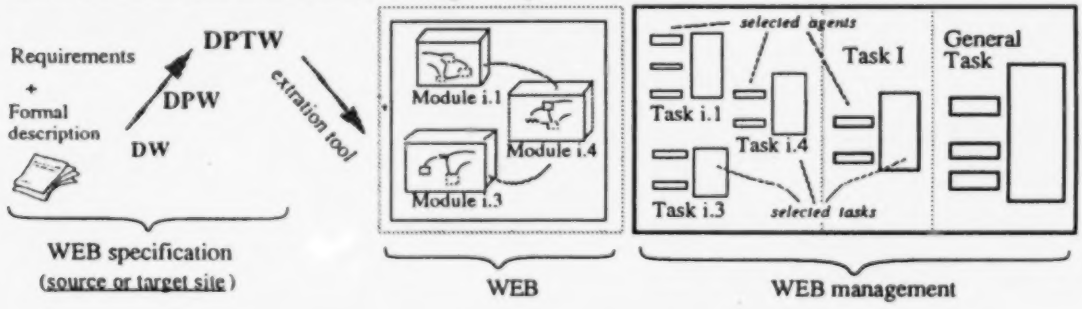

Figure 3. DPTW specification and physical WEB production

Extraction tool

The extraction is made from the DPTW specification ; hypermedia units and their supervision tasks have to be isolated :

- Information data is copied from the CD-ROM database,
- Links between the hypermedia units are copied (DW),
- Modules, Sequences and Pilot Agents are reorganized (DPW),
- Needed pedagogical and static links are copied (SL and PL lists), related information is stored,
- The object base is reduced to contain the only needed supervision parameters, and the necessary hypermedia information addressed by the selected agents.

Then the program, based on the target computer educational hypermedia management system and the MACT engine is produced.

Results and Prospects

In this paper, we have anticipated the second project stage, studying the theoretical and practical problems related to the educational hypermedia distribution. The WEB specification and extraction mechanisms are presented as a necessary solution from a technical point of view, but we also have focussed on the very interesting aspects involved from the pedagogical point of view. The first WEB specification and extraction experiments from an extended DEXTER formalism have been satisfying, although they have underlined the necessity to have heuristics allowing to help the instructor during the specification process. Other heuristics dedicated to the WEB optimization regarding to the target site constraints (e.g. screen or memory capabilities) are needed. In conclusion, from this first practical experience, we expect to make the theoretical model evolve, and we hope to draw a framework for optimizing the educational hyperdocument WEB specification... This study can also stands as a basis for structuring CAI/ICAI systems from which satisfactory and coherent parts can be extracted and run. But a great part of work is still to be done.

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